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Generally Speaking

New Tricks

With the continuously increasing use of very hard materials, of the metallic, ceramic, and intermediate types, the applications of diamond tools are correspondingly growing, and new techniques and methods are being developed constantly. Until recently, however, it has been thought that diamond impregnated tools, such as hones and grinding wheels, were unsuitable for use on normal steels, soft as compared with the newer materials, owing to the severe dressing action of such steels, or to the tendency for the tool to pick up steel and become quickly glazed, so that frequent dressing was necessary. In either case, the life of the tool was seriously reduced. For this reason, the superior finish that can be given by the use of diamond tools has been denied to these steels; now, however, we hear of a development that allows diamond hones to be used on these softer materials without any of the old disadvantages and all the benefits of finish that could be hoped for.

Right way round

A considerable amount of attention has been paid recently to the matter of the correct orientation of diamonds in diamond tools. Although all the necessary information has been available for a number of years, only a comparatively small application has been made of the knowledge until fairly recently. Experimental work indicates that the difference in the life of orientated and unorientated diamonds may vary by as much as ten times, a very considerable factor. So far, the principle has been applied only to whole-stone tools, but there is no reason to suppose that the results are not just as valid for the impregnated type, if a practicable and economical method of controlling the orientation of the diamond powder can be worked out. This is probably a fairly difficult problem, but should not be impossible of solution.

A bigger bit

One of the largest, if not actually the largest, diamond bit ever made has recently been delivered to the Shell Petroleum Co for use in Venezuela.* The finished weight is about two hundred-weight, and it is designed to bore a hole of over a foot diameter. There are 5,800 stones, totalling some 1,200 ct, set in a sintered tungsten carbide matrix. We should be interested to hear of any larger bits of which our readers may have heard.

ADAMANT

* Manufactured by L. M. Van Moppes & Sons, Basingstoke, Hants.

In-Plant 'Diamond Mines' Are Expensive . . . . . Spot Yours and Save

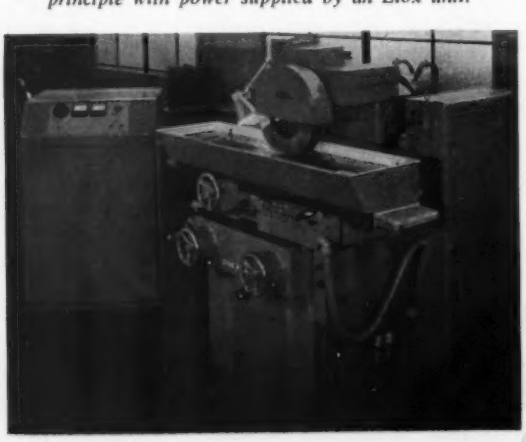
by Carol E. Reuss

Continued from p 112, June

Economical use of diamonds is synonymous with the use of substitutes when they 'fit the bill.' None of the presently available 'substitutes' for diamond grinding wheels—electrolytic, electro-spark, and ultrasonic grinding—is a panacea, but all merit consideration.

Electrolytic grinding is a fast and efficient diamond-assisted method for sharpening single point carbide tools. Pratt & Whitney Aircraft and a number of other users report that an 80-90% reduction in diamond wheel wear is possible with it. It can be used in applications which normally consume over 50% of the available diamond boart, C. R. Stroupe, vice president of Anocut Engineering Company, estimates. These include grinding materials which are as hard or harder than 60 RC, materials which are sensitive to heat because of possible thermal damage to metallurgical structure or warping, or which are tough and stringy and tend to burr in such a way as to require secondary grinding operations. Described as a combination of high speed etching and abrasive lapping, electric current is used to disintegrate rather than actually grind the material to be removed. A special metal-bonded diamond wheel is used, but it barely touches the workpiece surface. Its job is to clear away the disintegrated material and maintain clearance for the electrically charged coolant between wheel and workpiece. This method is two to four times faster than conventional grinding, depending on the material being ground. Surface finish varies from two to 12 micro-inches, depending also on the workpiece. Electrolytic grinding gives a matt finish to carbides, rather than a bright shiny finish. Some tool users hold this against the process, even though the matt finish is free from cracks and the ground tools have smooth edges.

Fig 9. A Cincinnati Elektrojet surface grinder. This one with a circular electrode operates on the electro-spark principle with power supplied by an Elox unit.



Thompson Products' tool grinding department installed an electrolytically equipped Hammond tool grinder last year. With conventional grinding, they used one grinding wheel per month; with the electrolytic grinding, the wheels lasted four to five months. They use an automatic power feed table on the machine to control automatically the amount of material to be removed. Pratt & Whitney Aircraft's Gallmeyer & Livingston surface grinder is used for chipbreaker grinding. Regular diamond wheels lasted through 2,500 cuts, the electrolytic wheel makes 25,000-30,000 cuts. To get the most out of the electrolytic grinding equipment, a shop must make certain that it has enough grinding operations to keep the faster machine busy and to justify the higher cost of the equipment. A completely 'packaged' electrolytic grinder sells for around $10,000. Many conventional grinders can be converted for electrolytic grinding by the addition of electrolytic supply units, such as those made by The Anocut Engineering Company. The price of these ranges from $400 to $1,000.

Electro-spark grinding does not use diamonds. A positively charged workpiece and negatively charged electrode or shaped tool are energized by a high amperage electrical current in a dielectric fluid. Controlled impulses remove particles of the workpiece when the tool and workpiece are brought in close proximity, forming a reverse image of the tool in the workpiece. This cycle is repeated many times a second, and the resulting surface on the workpiece has a uniform matt finish. The removed particles are washed from the surface of the workpiece by the circulating dielectric fluid. A Michigan manufacturer of electro-spark equipment reports that this method is 50-75% faster than conventional tool grinding on flat surfaces, and it saves 50-75% of tool cost. It is somewhat slower than electrolytic grinding but can produce more intricate shapes. Specific applications help decide the choice between electro-spark and electrolytic grinding.

Ultrasonic grinding is an abrading process: tool strokes a few thousandths of an inch, oscillating lineally at approximately 20,000 cycles/sec, bombard the workpiece and drive the abrasive grains against it. The workpiece is held below the tool, and a slurry of boron carbide, silicon carbide, or other abrasive is introduced between the tool and the workpiece. The rapid vibrations eat away the workpiece, duplicating the form of the tool. In the realm of carbide tool grinding it has so far had only limited application to chipbreakers. The hardness, brittleness, and density of the material being ground governs ultrasonic abrasive choice and the rate of stock removal. The more brittle the material, the coarser the abrasive used, and the faster the stock removal. Finish and accuracy depend on the size and finish of the tools, the fineness of the abrasives, and the material being ground. For roughing, Sheffield engineers report a 25 micro-inch finish available with 280 mesh abrasive. For maximum precision and smoothness with ultrasonic grinding, Sheffield engineers recommend more than one tool and mesh size be used.

Machining capacity, The Sheffield Corporation tells us, is limited by the power capacity of the transducer that operates the machine. This varies from 3½ to 0.006 in. diameter cavities. With ultrasonics, too, the job to be done determines the choice of method and equipment.

Your ' mine ' . . . the salvage bin

Three-and-a-half million dollars worth of diamonds were recovered from diamond swarf, sludge, and broken wheels by value-conscious diamond users in 1956. Judging from the increased use of diamonds, last year's salvage figures should be considerably higher. Salvage programmes can net as much as 30% to 50% of diamond wheel costs. Most reclaimers, however, estimate that a good salvage programme yields an average saving of 10% of diamond wheel cost.

Rule-of-thumb salvage rates for various types of wheels are: 4-5 carats/lb of swarf or sludge from resinoid wheels, 4 carats/lb from vitrified wheels, and ½ carat/lb from metal-bonded wheels. One reclaimer generalizes more by stating that most diamond swarf from carbide grinding operations contains 1-5 carats of diamond/lb of swarf. He admits, however, that if resinoid wheels are used exclusively, the concentration usually runs higher. This, of course, is because the soft resinoid bond wears away faster to expose diamond cutting points faster. Individual plant and/or operation differences will make reclamation figures vary, as will differences in reclaiming methods.

The best way to reap maximum carats and dollars from diamond salvage is to establish a definite full time salvage programme. First thing to do is to appoint a salvage co-ordinator—a responsible person with authority from the management to plan and install collecting set-ups; to indoctrinate machine operators, tool-crib attendants, and everyone else who might add to the salvage ' take '; and to keep the salvage programme rolling. The programme itself should take into consideration these hints, gathered from reclaimers and wheel users alike:

Collect diamond wheel stubs as well as grinding sludge and swarf, although the bulk of reclaimed diamonds will come from the sludge and swarf.

Fig 10. Small self-contained Torit diamond dust collector which operates on a special separating principle yielding a 30% return in salvage.

The TORIT Diamond Dust Collector is manufactured in Great Britain by INDUSMOND (Diamond Tools) Ltd of Greville Street, London, E.C.1, in association with the TORIT Manufacturing Co. and marketed under the name INDUSMOND-TORIT.

Fig 11. Diamond swarf and sludge can be shipped to reclaimers in a variety of containers.

Collect lapping cotton and rags, wire drawing dies, and dull or broken shaped diamond tools, if these are available from operations in your plant.

Separate wheel stubs from swarf and sludge, as they are reclaimed by different methods.

Keep diamond wheel sludge and swarf separate from non-diamond abrasive dust. Once the two are mixed, it is difficult to separate the diamonds, and the recovery rate is rarely satisfactory.

To collect diamond-bearing sludge from wet grinder operations, clean out the coolant tank, allow the swarf to settle, and draw off the water. Ship the semi-dry sludge, in water-proof containers, to the reclaimer. Use a coolant tank for diamonds exclusively. The additional recovery of diamonds from the segregated sludge can soon pay for the tank.

In dry or drip-wet systems, central dust collecting systems are often ineffective (for diamond recovery) because diamond dust becomes highly contaminated with non-diamond abrasives. Some shops do have effective special traps built into their central dust collecting systems, however. A baffle in each trap may be thrown one way during diamond grinding, and the other way during ordinary grinding operations.

Dust collectors are on the market for collecting diamond dust at the grinding machine. Torit Manufacturing Company's small self-contained model is a good example of this type of unit. One large automotive plant reports saving more than 30% of the carats originally contained in the grinding wheels since installing the small diamond dust collectors at each grinder. The units cost less than one diamond wheel used in the plant, and operate on a special separating principle that eliminates filters.

Diamond swarf should contain two carats/lb to make salvage worthwhile, some reclaimers suggest.

Send representative samples of swarf or sludge to various reclaimers to compare reclaiming results and to check diamond content.

Salvage is most profitable when 100 carats or more are contained in each lot of swarf or sludge. Some reclaimers pay a bonus rate for such large amounts.

Although reclaimers prefer working with large amounts of swarf, smaller accumulations are perfectly acceptable and normal, especially from smaller toolroom salvage programmes.

Three to six months' accumulation of worn-out wheels and swarf usually make what reclaimers call a ' workable lot '.

Vent moist sludge drums if fermentation from grinding compound residues is likely.

Build up salvage enthusiasm among employees. Keep telling them the dollar-and-cent value of salvage and reclamation programmes.

Diamonds . . . for truing and dressing

For fast truing and dressing, precise wheel concentricity and parallelism, and clean wheel faces, conventional abrasive wheels are best treated with diamond tools.

Since 1956 there have been two major types of diamond truing and dressing tools available: one utilizes a single large diamond or a cluster of large stones, set in a holder; the other has many small diamond particles, uniformly embedded in a binder. With either, abuse of the tools themselves is the biggest diamond—and money-saving factor. Fig 13-16 shows a properly used single-diamond tool, and the effects of improper use. Compare them with the condition of your truing and dressing tools to ascertain if and how such tools are abused in your plant.

Koebel Diamond Tool Company's sintered diamond particle (CDP) tools and form cutters are made of the more plentiful small diamond particles, like those used in diamond wheels. They are sintered together to form a homogeneous mixture, and, reports President Charles J. Koebel, each of the many particles " shares the load " in use. The strength of the tools does not depend on the strength of any one diamond, so the tools' characteristics are uniform and predictable. This was important to the Koebel-Jones & Lamson ' perpetual form control ' development, introduced last year, whereby formed wheels on an automatic form grinder are continuously dressed during the grinding cycle. CDP tools can not be re-set. When the diamond points become dull, they are worn off, much like diamonds in wheels.

'HABIT'

This Announcement....

is of compelling interest to all engaged in the shaping and polishing of gem diamonds, industrial diamonds, and other hard mineral substances.

THE 'HABIT' DIAMOND POLISHING MILL, or SCAIFE BENCH will shortly become available for delivery, and enquiries are therefore invited from Lapidaries in all parts of the world.

THE 'HABIT' MILL is a precision machine tool which supersedes the obsolete primitive conventional polishing bench, and offers the possibility of using mechanical methods of angular control.

Completely self contained, and of heavy, robust construction, it requires only connection to the electricity supply to be ready for work, especially designed bearings ensuring trouble free vibrationless performance.

The design is well proven, and the result of many years' experience in production of polished diamonds for industrial and gem purposes.

HABIT DIAMOND TOOLING LIMITED, probably the only Company currently specialising in the manufacture of special purpose and standard tools and equipment for the Diamond Industry, have produced this new unit to meet the ever-growing need of simplified polishing at a higher rate of production and lower cost.

HABIT DIAMOND TOOLING LIMITED

294-296, Lillie Road, Fulham, London, S.W.6. Telephone No : Fulham 7944.

'HABIT'

Numerous types of special truing and dressing tools are also available. For instance, Tandemite's new tool offers a pair of dressing devices in tendem. The two dissimilar points of contact are said to reduce the amount of pressure, heat, and friction on the diamonds, and to give longer tool and wheel life. Final choice of truing and dressing tools depends on many things—the grinding wheel, its use, the grinding machine, its operator, etc. It should be made in consultation with a diamond engineer or supplier.

These suggestions, however, can lead to diamond- and money-saving possibilities when truing and dressing tools are used:

Use the right diamond tool for the specific dressing and truing operations.

Mount the tool tightly and solidly in the toolholder.

Warm up the wheel-spindle bearings before starting to dress, so that conditions are similar to grinding conditions.

Guard against tool and machine vibrations which cause chatter marks, gouging, and breakage.

Handle diamond tools carefully. They are easily damaged when subjected to a sudden shock or blow.

Adjust the tool so that the diamond touches as nearly as possible to the 'work wheel' contact point.

Take light cuts—not over 0.001 in. for finishing.

Dress as nearly as possible to the wheel's grinding position.

Use correct drag angle—10-15° for a single point tool on external grinding wheels.

Approach the face from the highest point of the wheel (usually the centre).

Use plenty of coolant when dressing wheels used wet, and start the coolant flow before the tool contacts the wheel. Wheels used dry should be dressed dry; this is a slower operation because of the danger of overheating the diamond.

Use wheel speeds as near the grinding wheel operating speed as possible, never higher, except when truing the regulating wheel of a centreless grinder. This should be done at the highest speed available. Turn the diamond tool frequently for even and economical wear. Keep the cross travel even and steady across the face of the wheel. Finish the edges of the wheel with a diamond or abrasive stick, unless the wheel is to be used in grinding a square shouldered cut.

Scrub the wheel with water and a coarse brush after dressing—to remove fragments.

Fig 12. Coolant application and diamond reclamation are dual features of the Shoelborg Manufacturing Company's Vap-Air exhaust unit. It can be used with all standard universal tool and cutter grinders, specially dry type grinders, for which it supplies the coolant system. Use of coolant eliminates heat checks on the tools being ground and the exhaust system collects the diamond wheel swarf for salvage.

Check wheel and spindles to make sure they are running in balance. Dress wheels at regular intervals. Keep records to show the pieces ground/dressed to ascertain the best dressing times. Dress before the maximum number of pieces is handled, for economy's sake.

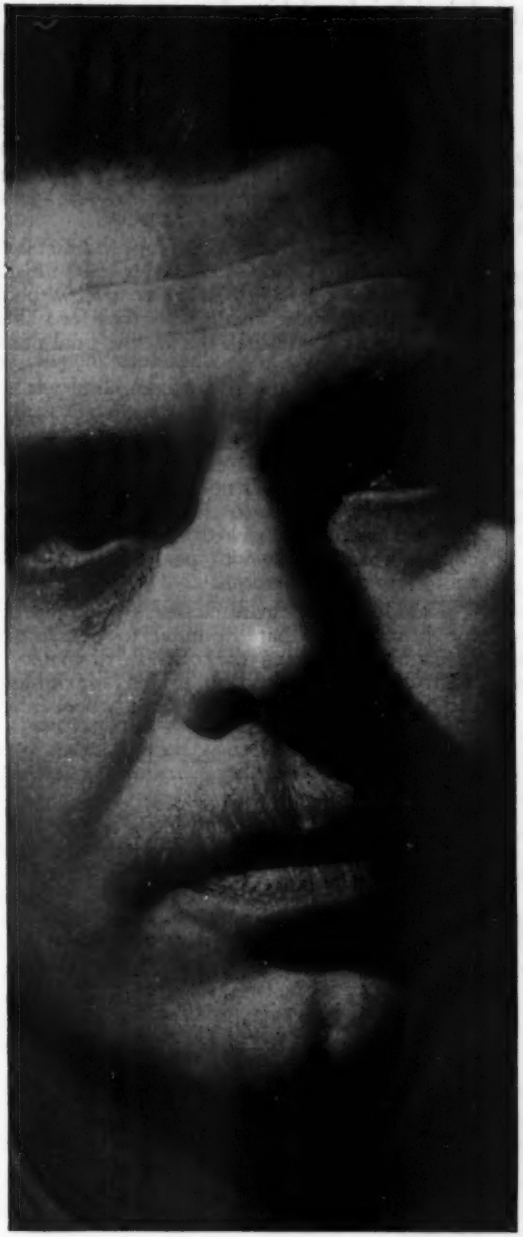
(To be concluded)

Germanium slicing machine

Germanium and similar crystals can be cut into slices or squares on the machine shown below. The cutting angle can be altered so as to obtain crystals with optimum electrical qualities. The diamond blades for the machine can be obtained in thicknesses of 0.20—0.30 mm.

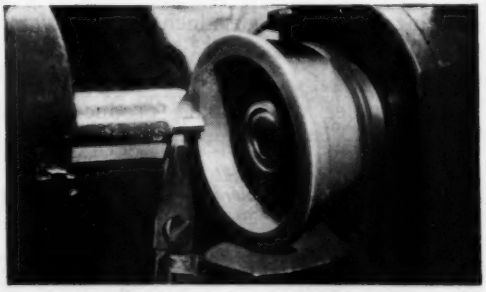
The machine is produced by Bunter SA, Lucens, Switzerland.

CUSTOMERS OF CARBORUNDUM



"We get more jobs out of each wheel with these" says **Tom Swain**

Tom Swain is the charge-hand of the cutter-grinding shop of Jonas & Colver (Tools) Limited. Most of the tools they grind there go to the motor industry or the aircraft industry. Among the most successful production tools that Tom's men use are the resin-bonded diamond wheels made by CARBORUNDUM shown in our smaller illustration. 'We find we get more jobs out of each wheel with these.' Tom says, 'And that's important with diamond wheels. Diamonds cost money!' He might have added that long wheel-life saves time spent in wheel changing, and so increases the production rate — not a big increase, but worth something in the course of a year.



CARBORUNDUM can help YOU

Tom Swain knows what he's talking about — and in almost all the major industries of the world there are men who talk about us in the same way that Tom does: men who know that products by CARBORUNDUM are helping them to make better products, to cut costs, and to speed production. Trade barriers in Europe are falling, and competition will sharpen as they fall. High quality, low price, and early delivery dates will be the keys to the expanding European market. There will be rich prizes for those who can meet the challenge of the new Europe. Abrasive and refractory products by CARBORUNDUM can help *you* to win them.

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TRADE MARK

THE CARBORUNDUM COMPANY LIMITED, TRAFFORD PARK, MANCHESTER. *Tel: Trafford Park 2381*

How to Grind Carbide Dies*

D. E. Oberg**

Concluded from p 118, June

It is important to select the proper wheel; a resinoid bonded wheel of the proper mesh size and bond hardness, with a bakelite core has proved to be very efficient. A special reinforced bakelite core adds greatly to the stability of the wheel.

Green grit wheels should be avoided; they present too many hazards of possible damage to the die. Metal cored wheels also should be avoided. Localized heat tends to warp the metal core out of round, causing a chattered finish on the carbide. This, in turn, leads to more frequent dressings and consequently much shorter wheel life.

An ideal combination of wheels would consist of a 100 mesh for roughing and a 180 mesh for the final 0.001 to 0.002 inch of cut, but the use of a 150 mesh wheel as an all purpose wheel has proved successful. Each of the three choices of wheel is recommended with the same general specifications, other than mesh size, that is to say, an 'R' bond-hardness, a diamond concentration of 100, a resinoid bond for wet grinding, and a one-eighth inch depth of diamond section.

Speeds and wheel widths

The grinder used should produce approximately 4,200 surface feet per minute at the perimeter of the wheel. The size of grinder required will depend on the dies being sharpened, and this factor will govern the selection of wheel width. In very large equipment the width may be as much as three inches for the greatest economy.

Table speeds should be approximately 85 ft/min for roughing and faster for finishing. Cross feeds of $\frac{1}{4}$ to $\frac{3}{4}$ inch are best for roughing, whilst for the best finish, the cross feed should be reduced to 1/32 inch during the final passes.

Fig 4. Run-out of diamond wheel re-mounted in the grinding machine after balancing must also be checked. Run-out on the wheel is as important as run-out on the spindle and is checked in the same way.

Wheel adjustments

Both the spindle and the wheel adapter must be checked with a dial indicator for true running. The flanges must be checked for burrs that might affect the proper fit of the wheel, and when the wheel is put on to the adapter, the size of the bore must be checked to see that it is large enough for the wheel to pass freely up to the shoulders of the adapter.

Diamond wheel manufacturers generally make the bore larger than nominal to permit some adjustment to bring the outside diameter into its true running position. This adjustment is the first to be carried out when a wheel is to be mounted.

The outer flange of the adapter should be placed in position and the screws lightly tightened. The run out of the wheel can then be checked on the side and on the grinding surface with a dial indicator. If the flanges are free of burrs and dirt, when the side is checked, the wheel should be found to be true running. If it is not, the cause of the trouble should be determined and corrected before the next step is undertaken.

When the edge has been passed, the periphery should be checked. Any necessary adjustments can be made by placing a small wood block against the high spot, and tapping it lightly with a hammer.

Finally, the assembled adapter and wheel should be checked for balance, and any necessary corrections made by adding adapter balance weights at the appropriate points. An out-of-balance wheel can cause rough surface finishes, and its life will be shortened by too frequent dressing.

From now on, until the wheel is completely worn out, it should never be removed from its adapter. The price of a separate adapter for each diamond wheel used at any given time is nothing compared to the cost of the setting up

time involved and the more frequent dressing that will be required if the wheel is removed from its adapter between uses.

Dressing the wheel

A brake-controlled dresser, with a silicon carbide wheel of 3 inches diameter, a 1 inch face, and a $\frac{1}{2}$ inch bore is recommended. The dresser should be placed on the grinder table or magnetic chuck with its spindle parallel with, and in the same vertical plane as, the spindle of the grinder. The dressing wheel must not be at all on the skew with regard to the grinding wheel. The accuracy of the parallelism and alignment is an important factor in economical and efficient dressing.

If the brake controlled dresser is set properly, it will travel at approximately 1,500 surface ft/min when driven by contact with the diamond wheel travelling at normal speed.

Some operators start the dressing wheel spinning with a small wooden stick, but it can be done better and more safely if a small knurled knob is added to the dresser spindle. Whatever method is used, it is important that the dresser wheel should be spinning when it first makes contact with the diamond wheel. If this precaution is not taken, a flat will be ground on the dressing wheel that will damage the diamond wheel as the dressing proceeds.

The diamond wheel should be moved over the dressing wheel parallel with the grinder spindle; no coolant should be used.

The wheel should be down-fed at about 0.0005 to 0.001 inch for each pass and after a cut of about 0.005 total depth has been taken, the diamond wheel should be stopped and the results checked. The procedure should be repeated as often as necessary to obtain a true and smooth surface.

The colour of the diamond wheel will be the same over the entire face when it is dressed true. The purpose is to dress away the wheel bond, make the wheel true, and expose sharp diamond particles to make a clean cut. A sharp true-running wheel gives an excellent finish on the face of a punch or die. Frequent use of the cleaning sticks furnished by the wheel manufacturers will keep the wheel open and cutting.

In cases where a large number of wheels is in use, a wheel salvage programme should be considered.

Preparing the die for grinding

All oil, chips, and foreign material on a carbide die must be cleaned up before the sharpening is begun. All set-edges and lifters

Fig 5. Dressing the outside diameter of the diamond wheel absolutely true and round with a silicon carbide wheel on a brake-controlled dresser.

must be removed from the dies and push pins, and all pilots and other appurtenances from the punch. The bottom of the shoe and the top of the punch holder must be inspected and any burrs that might prevent the die or punch from being held flat on the grinder chuck must be removed.

The punch and die must be inspected to determine how much material must be removed from them to produce good clean cutting edges. It may prove better to replace sections showing excessive wear or chipping to avoid excessive grinding of the entire surface.

Grinding

The die should now be chucked on the grinder, and, if the machine has automatic table traverse, the stops should be set so that the wheel passes at least one inch beyond the ends of the die at each pass. The cross index and table speeds should be set as already recommended, and the wheel brought into contact with the work.

During the grinding of carbides by diamond wheels there is no display of sparks such as are seen when steel is ground with synthetic abrasive wheels. In fact, diamonds, though beautiful in a piece of jewellery, have no aesthetic value on the surface of a grinding wheel. Grinding is not done by sight but by ear; a light hissing sound tells when the wheel is in contact with the work.

After the first contact, the wheel should be raised about 0.002 inch, and returned to the cutting position by a down feed of 0.0002 inch on each pass. Roughing cuts should not exceed

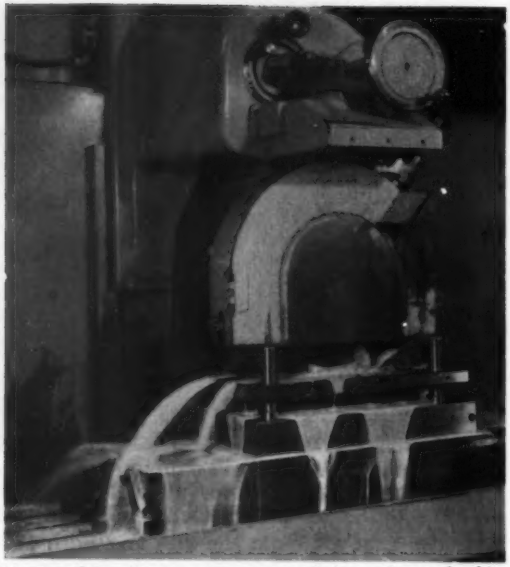


Fig 6. The die can be protected from heat checking damage and the life of the diamond wheel prolonged by a copious, uninterrupted flow of clean coolant. Grinding the carbide punch is relatively simple, since the stripper is made to fit with very close tolerances, and can be conveniently used for support when raised near the cutting end of the punch, giving maximum support with minimum punch exposure. Only two guide pins remain in the punch holder for alignment; any two outside pins which will allow clearance of the wheel over the entire area of the punch can be used.

0.0002 inch, and finishing cuts 0.0001 inch, with several free passes between feeds.

If the machine is stopped at any time during the grinding the wheel should again be raised about 0.002 inch before being down fed on to the work again by increments of 0.0002 inch. This is necessary to allow for possible changes in elevation of the table from the accumulation of oil on the bearings during the shut-down. The total depth of cut necessary can be established by plunging the width of the wheel right through the area requiring the heaviest cut. Successive passes should be made until all signs of wear have been removed along that path. The wheel should then be lifted back to the starting height, and the standard procedure used until the last pass across the whole die removes the first wheel path.

A double check should be made of all cutting edges before the tool is removed from the grinder to avoid the possibility of additional handling.

If the total depth of grind is to be more than 0.01 inch, as much as possible of the shoe and die steel material should be removed with an aluminium oxide wheel before the diamond wheel is brought into use. Tool steel has a dressing action on the bond and wears down a diamond wheel much faster than carbide, so that unnecessary grinding of steel with diamond wheels should be avoided

Grinding the carbide punch is relatively simple, since the stripper is usually made to

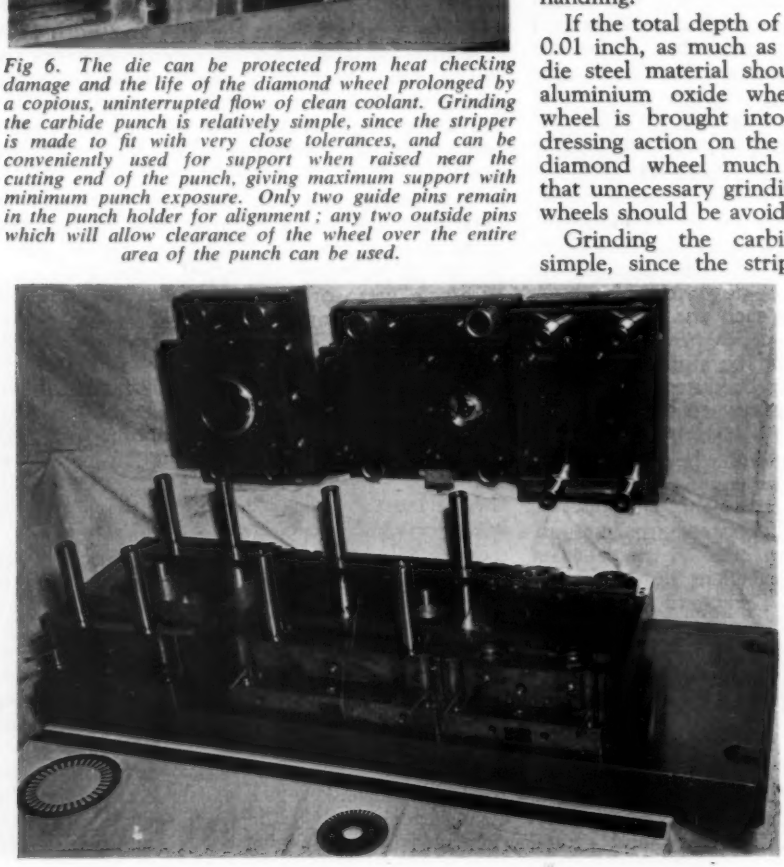


Fig 7. A large progressive carbide die set producing a 7⅛ in. diameter stator and a 4⅛ in. rotor, an assembly which requires the highest precision in grinding and maintenance. Proper grinding makes this kind of die set very economical for large production runs.

fit with a very close tolerance. This means that the stripper can be used as a punch support

The guide pins on one side of the punch assembly should be removed, and the stripper raised on the punch to give the minimum exposure and maximum support.

If the stripper is not guided, a punched piece from the last run can be used as a support for slender punches. Care must be taken not to chip the punch as the strip is put in position or removed after grinding.

Cleaning and reassembly

After grinding, both die and punch must be thoroughly cleaned; all sludge, grit, and foreign material must be washed off, and special attention should be paid to stripper guide bushings, pin bushings, and greasing cavities, as well as punch and die openings. After cleaning, the entire assembly should be dried and demagnetized.

All pilots, push pins, and other devices must then be inserted in the punch, and care taken to ensure that all back-up screws are in place when the stripper is refitted. The stripper can be drawn back if necessary by washers placed under the heads of the stripper bolts, provided that care is taken to see that the washers under each bolt-head have exactly the same total thickness.

The stripper springs must not be over compressed, as this leads to early spring failure. Shorter springs, or fewer washers under the springs can be used to give the correct spring pressure and deflexion. If the stripper has been drawn back, the pilots and push pins must be reground to the correct length.

The lifters and the set-edges should be replaced in the die, and grease applied; Lubri-plate No 130AA or equivalent is recommended. The die is then ready to return to the press.

These instructions may at first appear to be rather tedious, but strict attention to details will pay off in cleaner cutting, greater production between grinds, longer die life, and more economical use of diamond wheels. It is well worth the effort.

* Abridged from an article in *Grinding and Finishing* Oct 1957 with permission from the authors and the publishers.
** General Manager, Oberg Mfg Co., Inc., Tarentum, Pa., U.S.A.

An Ingenious Adaptation

When the firm of Precision Optical Products started up a year or so ago, as specialist suppliers of high-precision optical components, one of their most urgent requirements was a lens-edging machine. There were two difficulties standing in the way, however; one was the cost, at that time a serious matter to a new company, and the other, even more important, the long delivery time quoted by the machine makers. For this reason, the operation of optical edging the firm's lenses had to be put out to a sub-contractor, a solution that was unsatisfactory for several reasons. Another answer, therefore, had to be found, that would not be too costly, and could be brought into operation fairly quickly, and there the experience and ingenuity of one of the senior members of the company brought quick and satisfactory action.

Mr. Myhan, of Precision Optical Products, who had a good many years practical experience in the optical industry, was interested in motor cycle racing, and had seen the type of equipment used in tuning shops for refacing the valves of racing machines, a work calling for a very high degree of accuracy and finish to achieve the optimum results. It occurred to him that a machine of this type could be adapted for lens edging, and after some study of various types, it was decided that a Wolf Heavy Duty valve Refacer, Type SR 54 could be used for the purpose. It was found that this machine could do the work with practically no modification, and it has been doing the job to everyone's complete satisfaction ever since.

After grinding to their correct optical form, the lenses are mounted individually on a mount for edging in the Valve Refacer. Centring is carried out by a reflexion method, using the standard light fitting on the machine as the light

The Wolf Heavy-Duty Valve Refacer, type SR 54, being used for lens edging at Precision Optical Products.

source, and the edge grinding, which ensures that the optical and geometrical centres of the lens, in its finished form, are coincident, is then started. The grinding wheel, purpose-made for the work, is started, and the lens on its mount fed in to it. The amount to be removed varies between 50 and 100 thousandths of an inch, and must be completed to an accuracy of ± 0.001 inch for concentricity. The time taken for the operation is approximately 5 minutes.

In addition, it has proved possible to use the same machine, with minor modifications, to carry out several other operations, all to the required accuracy, and what was originally looked on in the light of a stop-gap has proved to be a most valuable and versatile tool.

Diamond Powder Recovery with Heavy Liquids

J. Swimmer*

Application of heavy liquids to the recovery of diamonds and other valuable minerals is not new, but recent improved methods of manufacture of methylene iodide, (MI[1]) one of the key heavy liquids required, have reduced its cost and toxicity to make it practical for use in recovery of diamond powders from mixed abrasives, metals and metal carbides. Improved methods of in-plant recovery and re-use of MI have reduced its actual cost-to-use far below the use-cost of non-re-usable chemicals, such as potassium or sodium hydroxide, for example.

Preliminary treatment of industrial wastes as outlined by Miss J. Abel (*Ind Diamond Rev* 1957 pp 25-27) in paragraphs 1 to 4 will give a clean powder of mixed abrasives which need treatment to remove silicon carbide and alumina from the diamond. The clean powder is mixed thoroughly with 10 times its own weight of MI in a centrifuge tube (75 gm of powder mixed with 250-275 ml MI in a 300 ml tube is practical) and centrifuged at about 1500 rpm. MI has a specific gravity (SG) of 3.3 silicon carbide (SC) of SG 3.2] will float in MI while diamond, alumina, metals and metal carbides, garnet, zircon, etc will sink in it. MI wets diamond powder mixtures rapidly and thoroughly because it is a hydrocarbon. Aqueous solutions do not wet these powders adequately for quantitative separation. The float layer of SC which will also contain any boron carbide or other siliceous matter such as glass, quartz, mica, etc is poured off into a buchner funnel and the MI sucked from it into the same filter flask. The diamond and SC are washed with acetone while in their respective buchners but into a separate filter flask. The separate powders are put on trays to dry. A heat lamp will speed drying. The acetone wash liquor is poured either immediately or at most within 8 hours into 10 times its own volume of water which immediately precipitates the contained MI. The bulk of the MI will gather at the bottom of the container immediately and a small milky part takes about 10 hours to settle out. MI filtered off the solids is, of course, immediately ready for re-use and the acetone wash MI is readily prepared for re-use as follows, after a sufficient amount has been accumulated. The top layer of acetone-water solution is poured off and discarded. The MI layer is then shaken twice with two volumes of cold water. The water is poured off and discarded. The MI is separated in a separatory funnel from the last layer of water. It is then filtered 2-3 times through a buchner funnel using dry filter paper each time. This filtration removes any dirt, residual water and acetone. Any MI in the filter papers and glass ware is washed out with acetone for re-recovery.

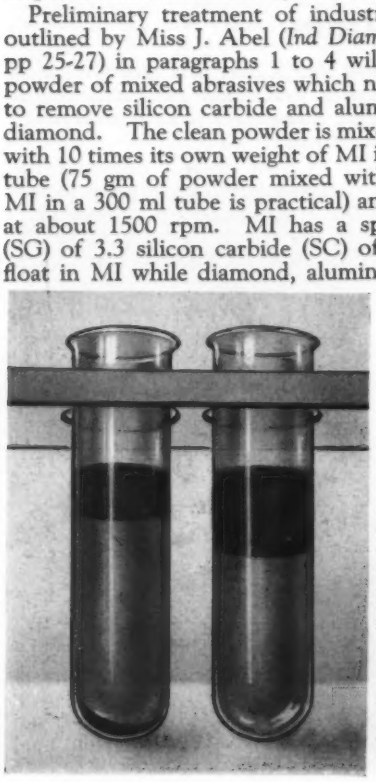


Fig 1. (left) After 5 minutes centrifuging, showing separation of diamond from silicon carbide ;

(right) After 45 minutes standing without centrifuging— no separation.

Using this method of recovery and re-recovery of MI, the loss per use is from 0.25 to 1% of MI with about 0.5% average. Thus at a loss of 1% per use, 1 pound of MI does the work of 50 lb and at ½% it does the work of 100 lb. Therefore at a laboratory quantity price of $10 per lb. and 0.5% loss basis MI costs only 10 cents per pound per use plus about 0.5 cents per use for acetone. And on a plant

1) MI-GEE is the Trade Mark of National Diochemical Co.

Fig 2. A 300 ml stainless steel tube which can be used for centrifuging at the highest permissible speeds.

quantity purchase with an 0.33% loss the cost is 5.5 cents per pound or less including acetone. Compare this with the price of such a common chemical as potassium hydroxide at 50 cents per lb on a laboratory basis and 15 cents per pound on a plant basis. One pound of MI will yield hundreds of carats of diamond while 1 lb of patassium hydroxide is just lost with only 100 carats of diamond. Consider that freight transporting a single pound of MI to the user is the equivalent to paying the freight on 100-200 pounds of other chemicals because of the re-use factor. This alone practically pays for the MI if nothing were involved. A centrifuge is required for best results using MI.

In order to bring the purity of the diamond up to 99% plus, it is treated in the same fashion as before but with a patented[2] liquid called HI-GEE[3] which has a SG of 3.55 at room temperature.

HI-GEE is an organic mercury compound dissolved in MI. The contaminated sink portion from above is mixed with HI-GEE and centrifuged. Diamond of SG 3.5 floats while

2) US Patent No 2,730,235 Liquid separating medium and use thereof. also British Patent No 745,764, Union of South Africa Patent No 19,710: Canadian Patent No 532,015.
3) Trade Mark of National Diochemical Co.

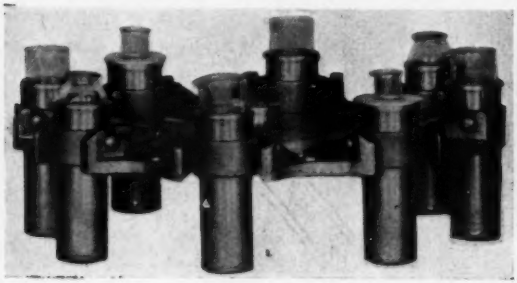
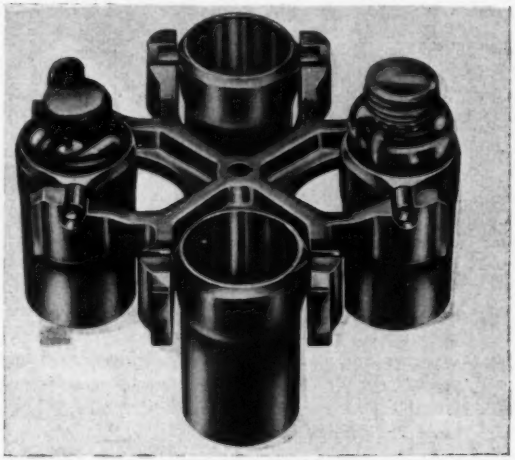


Fig 3. (above) An eight-place centrifuge head for 50 mm tubes;

Fig 3. (below) A four-place head for 300 mm tubes.



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alumina of SG 3.6-3.9 sinks along with metals, metal carbides and oxides, garnet, zircon, etc. The float portion of diamond is poured into a buchner funnel and the HI-GEE filtered from it into a filter flask. The sink portion is poured into another buchner and filtered into the same filter flask. The contents of each funnel is then washed with warm MI (120°F) into a second filter flask. This removes most of the HI-GEE. The funnel contents are then washed with acetone into a third flask. The diamond float portion from HI-GEE is given another spin in clean MI in the centrifuge which removes the last traces of HI-GEE and any trace of SC in the powder. Wash MI is recovered from acetone wash liquor as before with water and filtration but kept separately because it contains valuable HI-GEE. Wash MI gradually builds up in gravity with use to a point where it takes only a little HI-GEE solute to build it up to proper gravity. This HI-GEE solute is recovered from acetone wash and added to MI wash. In this manner over a period of 5 years only 10-15% of the HI-GEE solute is lost and the only loss in the process is MI which is used up at a rate similar to plain MI above. Even with the price of HI-GEE at $50 per pound the cost over a period of years in use is only 10-20 cents per pound per use for laboratory work and in plant size quantities 5-10 cents per pound in use. Here again in the freight saving is 100-200 to 1.

With the two liquids of SG 3.3 and 3.55 diamond is easily purified to 99% plus. Extremely fine powders in the minus 15 micron range must be as clean as for grading and they must be centrifuged at speeds up to 2500 rpm which means smaller tubes and sturdier heads. Since most centrifuges are made with the idea of being used with water of SG 1.0 they must not be used at more than 60-75% of their water rated speed without being carefully safety tested when using these very heavy liquids.

We have traced conflicting reports on the toxicity of methylene iodide to certain materials added during or after manufacture, and these are not present in MI-GEE. This permits it to exhibit only its natural toxicity which is lower than had been previously thought. By comparison with methylene chloride it is estimated that the threshold limit for constant 8 hour exposure to MI-GEE vapours is 50-100 rpm.

The figure for methylene chloride is 500 ppm, chloroform 100 ppm and carbon tetrachloride 25 ppm (values for these three from *Archives Ind Hyg Occup Med* 1953 Vol 8 p 296 (Sep)). Owing to its high boiling point (and therefore low vapour pressure) the 100 ppm value is not easily reached as compared with more volatile solvents, and the fumes are easily detected by their odour and readily dispersed with moderate ventilation. As with any solvent MI-GEE should be used with adequate ventilation.

HI-GEE is more toxic than MI-GEE but is only about 1/20 as toxic as thallium salts. Thallium salts in aqueous solutions do not wet diamond powders properly or as rapidly as MI and HI-GEE. Neither of these two liquids has the potential danger of splashing that large quantities of hot fused chemicals do during handling or dissolving. Neither represents a possible booby trap as sodium fluoride does. Adding acids to solutions of sodium fluoride generates deadly HF gas and acid. Water solutions of fluorides appear similar to many other ones in a reclaiming factory and quantities of acid are always near. MI and HI-GEE are easily identified at all times and usually kept away from acids which decompose them harmlessly.

Fig 1 shows why a centrifuge is necessary in working with diamond powders even though both MI and HI-GEE are very mobile liquids (not thick and syrupy). The tube at the left was centrifuged for 5 minutes at 1500 rpm with quantitative separation of the diamond (sink portion) from the SC (float) while the tube at the right stood for 45 minutes with no diamond separation at all. These powders are minus 325 mesh. Powders of plus 20 mesh need not be centrifuged but much time can be saved and more consistent results are obtained centrifuging even coarse powders. Fig 1 shows 50 ml glass tubes used for most normal work, but 50 ml stainless steel tubes similar to the 300 ml one shown in Fig 2 are available for use at the highest permissible speeds. Light weight polyethylene is attacked by MI and HI-GEE but can be used a good number of times before it is badly cracked and needs to be discarded. If the liquids are poured out of them promptly tube life is quite long. The very highest speeds are necessary when working with powders of minus 15 micron size.

Fifty ml tubes fit into an 8 place head shown in the top of Fig 3 and the 300 ml tubes fit into a four place head shown in the bottom of Fig 3. Four 300 ml tubes have a solids working capacity of 300 grammes at one time. Eight 50 ml tubes handle 120-150 grammes at a time.

(To be concluded)

' Diamant '

A new monthly journal has recently commenced publication covering all aspects of the diamond trade. It is published by Sam Emmerik, Muggenberglei 23, Antwerp, Belgium, and the principal articles are given in English and French as well as Flemish.